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# A Universal Sound-Vision Unit for FM-ATV Transmitters

The unit to be described displays characteristics which justify the claim that it is truly universal.

The composite signal comprises the processed video signals and the frequency-modulated sound carrier. The so-called base-band signal is available at a high level (4  $V_{po}$ ) at the 75  $\Omega$ 

coaxial output. As any video signal at this impedance, it can be taken via any length of coaxial cable (figs. 1a and 1b). This module does not have to be in the vicinity of the modulated GHz oscillators (or Gunnplexers) and it can, moreover, feed two ATV transmitters simultaneously (fig. 1c).

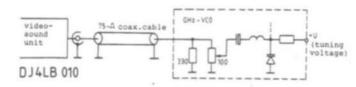


Fig. 1a: VCO level adjustment

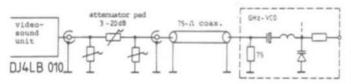


Fig. 1b: Level adjustment using a 75  $\Omega$ pad at the video/sound output

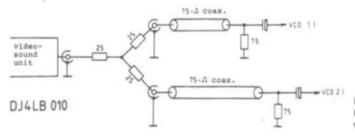


Fig. 1c: Using two VCOs at a video/sound output



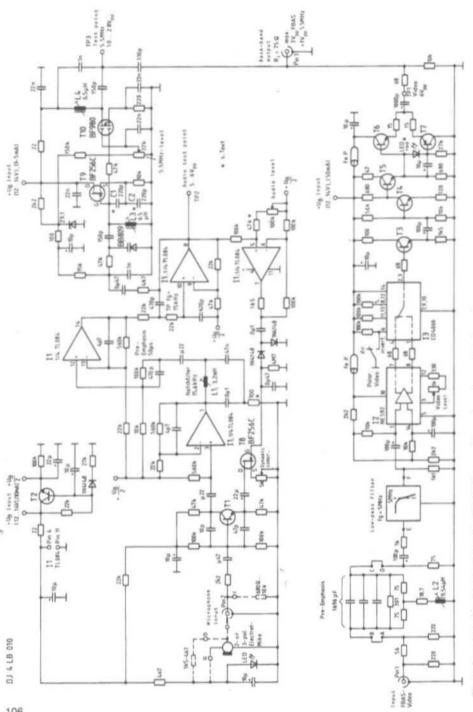


Fig. 2: Complete circuit schematic of the FM-ATV transmitter universal sound/vision unit



The polarity of the processed video signal is reversible. This facility may be necessary under three circumstances as explained in (1).

The sound-carrier circuit is suitable for all frequencies which are used in both amateur- and satellite television (approx. 5.5 to 7.5 MHz).

This unit is self-contained inasmuch that all the components necessary for the base-band processing, including a supply voltage for electret microphones, and a video block filter are incorporated. Thus, no additional modules should be necessary.

The relatively high sophistication not only ensures a high sound and vision quality but also serves to limit the modulated spectrum to that which is necessary compatible with the fidelity offered.

# 1. CIRCUIT DESCRIPTION

The complete circuit of the universal sound-vision unit may be seen in fig. 2.

# 1.1. Video Processing

# 1.1.1. Video Pre-Emphasis

A 6 dB pad precedes the pre-emphasis network in the signal path from pin 1. The PE-network attenuates signals lower than 100 kHz by some 14 dB (2) whilst allowing signals of greater than approximately 3 MHz to pass without attenuation. Both BAS and FBAS signals contain relatively large components at frequencies over 3 MHz which remain largely unaffected by the PEnetwork but the form of the composite signal has been clearly changed (see fig. 3a). It will be seen that the video test-signal has encroached deep into the synchronizing pulse area and exceeds the amplitude of the sync-pulse. This would preclude satisfactory synchronization in any monitor! The signal relative amplitudes must therefore be restored in the demodulator with a de-emphasis network (2). If the latter

were to be experimentally applied to the output of the video-amplifier at pin 3, the original signal form is then restored, as in fig. 3b.

#### 1.1.2. Video Low-Pass Filter

Experience has shown that many amateur video signals are transmitted with components well in excess of 5 MHz. This is not normally to increase the resolution (exception: charactergenerators etc) but the result of unnecessarily abrupt sync- and blanking pulses. Video signals components which are higher in frequency than

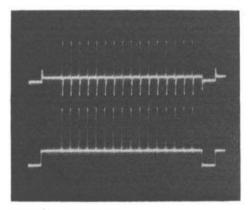


Fig. 3a: Line frequency: before pre-emphasis (below), after preemphasis (above) using same unit scale

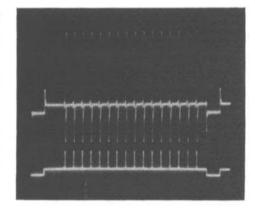


Fig. 3b: Line Frequency: before de-emphasis (above), after deemphasis (below) using same unit scale



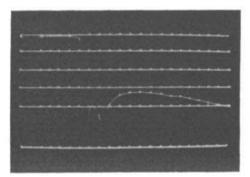


Fig. 4: 0 - 20 MHz 1218 block filter

Fig. 5: One line of B/W video: before the video block filter (below), after the block filter (above)

5 MHz cannot be displayed in a normal PALnorm monitor and therefore it is not necessary for them to be transmitted in the first place. They can cause modulation to the sound carrier which further increases the total transmitted bandwidth in the range 5.5 to 7.5 MHz.

These unwanted high video components are removed by the low-pass filter which has a 5 MHz limit frequency. The LPF is located in the video path shortly before it is combined with the sound carrier. A suitable filter here would be the prealigned "video block-filters" which are available in a miniature LC-technology. These may be obtained from Componex Düsseldorf under the designation 5 VFQ 1218 (or 1919).

Fig. 4 shows the video-output frequency response with the filter fitted between pin 1 and pin 3 (without pre-emphasis). Both filter types attenuate all frequencies above 5.5 MHz by more than 30 dB. The filter 1919 is characterised by a wider video bandwidth making it suitable for character and computer transmission but the "1218" has a higher attenuation in the vicinity of the sound carrier between 5.5 and 8 MHz. These small differences do not, in practice, appear to make a great deal of difference even with a variety of video sources, so it is quite in order to select on the basis of what is available.

Fig. 5 demonstrates the effect of the described video block-filter on a BAS signal. It can be seen

that the high-frequency components of both the sync and the spurious needle pulses have been suppressed at the end of the front black porch. The original value of the voltage has been halved and thereby the sender deviation — for the same video quality!

# 1.1.3. Video Amplifier

The integrated circuit I 2 (NE 592) delivers at its output (7 and 8) two equal amplitude video signals but of opposite phase to each other. They are taken on to I 3 4 x CMOS switch (CD 4066). Two of these CMOS-switches form the actual video change-over. The opposite polarity control voltage switches the other "contacts" in the chip to earth.

The drive to the complementary output stage T6/T7, is a conventional x 4-transistor stage (T4) and is necessary because the undistorted output of I 2 is only 3  $V_{\rm pp}$ .

## 1.2. Audio Processing

## 1.2.1. Audio Amplifier

Figures 6a, b and c show the circuit details of the connections of the various microphone types to the audio amplifier. These input stages are fitted with a single low-noise transistor as standard ICs, even FET input types such as the TL 074/084, exhibit 10 dB more noise. A careful compo-



nent layout and arrangement of the board conductor tracks avoid any inter-action with the video circuits sharing the common PCB and serve to prevent the ingress of the video voltage at 15 kHz into the sensitive microphone amplifiers.

#### 1.2.1.1. Audio Notch-Filter

TV receivers and monitors radiate their line frequencies not only in an electrical fashion but also audibly. It is hardly avoidable that any microphone in the vicinity will pick up this 15 kHz tone and feed it, together with the speech frequencies, through the audio chain. Fig. 7 above, shows the AF voltage corresponding to the spoken "A" and which is being modulated by the line frequency. The consequence of this, is a 15 kHz spaced spectral comb on the sound carrier and/or an automatic overloading of the audio amplifiers which results in a lower deviation for the speech signals. This may be avoided, as shown in fig. 7, by the notch-filter comprising L1 tuned to 15.6 kHz. The effects of this filter may be seen in the lower trace of fig. 7.

#### 1.2.1.2. Audio Pre-Emphasis

A standard 50  $\mu$ s pre-emphasis network has been included in the audio signal path. Its function is described in detail in reference (1).

#### 1.2.1.3. Audio Low-Pass

The noise spectrum of the input stage does not end at the AF limit frequency. In addition, the presence of the audio pre-emphasis network boosts the noise at 30 kHz by some 6 dB relative to that at 15 kHz. Therefore, in order to limit the audio bandwidth, the last stage of the AF amplifier is fitted with a Butterworth characteristic, low-pass filter with a 15 kHz limit frequency.

# 1.2.1.4. Automatic Level Control and Dynamic Compression

A fast-acting control circuit influences the amplification of transistor T1. This has the effect of reducing input amplitude signal variations of

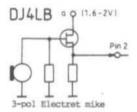


Fig. 6a: 3-pole electret microphone connections

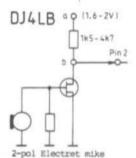


Fig. 6b: 2-pole electret microphone connections

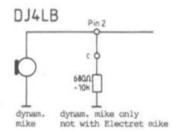


Fig. 6c: Dynamic microphone connections

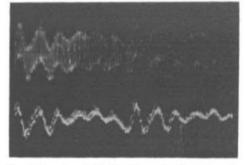


Fig. 7: A spoken "A" before the notch-filter (above), after the notch-filter (below)



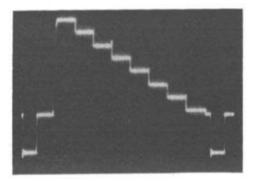


Fig. 8: Line of grey steps without sound carrier

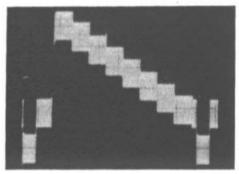


Fig. 9: Line of grey steps with sound-carrier component (-13 dB)

between 1 mV $_{pp}$  and 70 mV $_{pp}$  to an almost constant output voltage of 5.5 V $_{pp}$  at TP 2. This serves to give a defined frequency deviation for the TV-sound carrier.

#### 1.2.2. Sound Carrier Generation

The spectral purity of the sound carrier demanded in (1) can be attained by a combination of circuit measures:

A very small current (0.3 mA) through the oscillator transistor T9.

Galvanic coupling from the hot end of the lowharmonic oscillator tuned-circuit to gate 1 of T10. It will be apparent, that because of this, the effect upon the oscillator frequency when it is being aligned, either by varying the tuning voltage or by de-tuning the tuned-circuit L4 core, will be some 30-times smaller than would be the case if the coupling had been taken directly from the source via a coupling capacitor in the normal manner.

Frequency-independent coupling to the 75  $\Omega$  output via a capacitive divider instead of the more usual 10 pF capacitor direct from the hot end, also favours the suppression of harmonics.

At the specified deviation of  $\pm$  50 kHz, extensive tests have determined that at a mean DC-operating point on the varicap of 9 V, only the very smallest of distortion is measurable.

# 1.3. Video-Sound Carrier Coupling

The sound-carrier voltage is taken capacitively from the 75  $\Omega$  output, pin 3. This has the advantage over a common output for both video and sound carriers that the sound carrier is not affected by excessive video over-modulation.

Fig. 8 shows a test picture taken from one of the output sockets which has no audio component. Fig. 9 shows a sound carrier which has a -13 dB (approx. 23 % of the video amplitude) of video modulation.

# 2. CONSTRUCTION

#### 2.1. Printed Circuit Board

For the reasons given in 1.2.1., the module is best constructed using the copper-foil, single-sided, printed circuit board designation DJ4LB 010 (fig. 10). It will be found convenient to install the proprietary coil L2 after adjusting it first to an inductance of 9.5  $\mu$ H.

If the sound-carrier oscillator is required to work on a frequency other than that of 5.5 MHz, the source resistance of T9 must be changed to achieve the same RF level. The appropriate resistances are given in table 1. It may also be



Frequency	R <sub>source T9</sub>	AF voltage at TP 2 for ± 50 kHz deviation
5.5 MHz	10 kΩ	5.4 V <sub>pp</sub>
6.0 MHz	9.1 kΩ	5.0 V <sub>pp</sub>
6.5 MHz	8.2 kΩ	4.6 Vpp
7.0 MHz	6.8 kΩ	4.2 Vpp
7.5 MHz	5.1 kΩ	4.0 V <sub>pp</sub>

#### Table 1

necessary to change the value of the 47  $k\Omega$  resistor in series with the "audio level" set pot'meter in order to bring the specified deviation into the range of this pot'meter.

# 2.2. Component Selection

1: BC 550 C, BC 413 C (low-noise NPN)

T2...T6: BC 547 B or equiv. (NPN)
T7: BC 557 B or equiv. (PNP)

T8, T9: BF 256 C or BF 245 C (JFET)

T10: BF 980 or equiv. (DG-MOSFET)

11: TL 084 or TL 074

12: NE 592

13: CD 4066

1 red LED, 5 or 3 mm dia,  $U_F = 1.6 \text{ V}$ 

1 LED, any

3 universal diodes 1 N 4148 or equiv.

1 Z diode 9.1 V

1 varicap BB 809 (Siemens)

L1: Inductor approx. 3.2 mH (Neosid-Type 5902)

L2...L4: Inductor approx. 6 - 10 μH (Neosid 5800)

2 ferrite beads 5 mm long

Ceramic Capacitors with RM = 2.5:

2x 4p7 1x10p

. . . . .

1 x 47 p

2 x 1 n (RM = 2.5 and 5)

Styroflex Capacitors:

2 x 150 p

1 x 220 p

1 x 330 p

3 x 470 p

1 x 1696 pF (3 x 560 p)

Mica (TK = 0): C2: 220 pF

MKH-Caps. (Siemens), RM = 7.5 and 10:

4 x 22 nF

1 x 47 nF

1 X 4/ H

2 x 100 nF 2 x 220 nF

3 x 470 nF

Elco, 16 V, upright, RM = 2.5:

8 x 10 μF

2 x 22 µF

 $4 \times 100 \mu F \text{ (or RM} = 5)$ 

Elco, 16 V, horizontal, max. 16 mm dia., max. 30 mm long: 1 x 1000  $\mu$ F

Preset pot'meters, horizontal, RM 10/5: each 1 x 1 k, 5 k, 25 k, 100 k

The following 4 resistors are to be found in the E96 series:

18.7 Ω, 75 Ω (3 x), 301 Ω, 698 Ω.

Note:

RM = lead spacing (mm),

Elco = electrolytic capacitor

The temperature drift of the sound-carrier oscillator depends largely upon the type of tuned-circuit capacity used. With a temperature change of  $\triangle t = +$  1° C the following frequency changes are to be expected using the indicated types of capacitor for C1 and C2:

△f = - 250 Hz (styroflex)

 $\triangle f \approx +350 \text{ (mica)}$ 

△f ≈ + 100 when C1 is styroflex and C2 is mica

Once the proximity effects of other components have been adjusted for, the sound carrier will work in a stable fashion even without enclosure in a metal housing.

## 2.3. Housing

The Euroformat (100 x 160) board mounted with 5 mm clearance above the housing floor, will fit into a proprietary tin-plate box which has a height of 30 mm — see fig. 11.

When wiring the connector sockets, the following points are to be observed: The microphone-cable screening mantle should not make contact



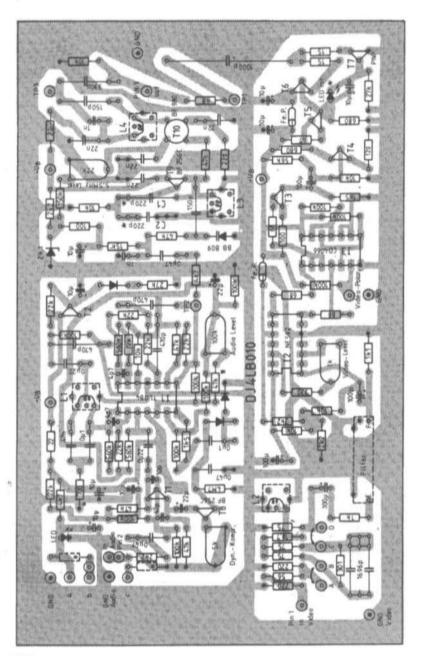


Fig. 10: Component layout plan of PCB DJ4LB 010

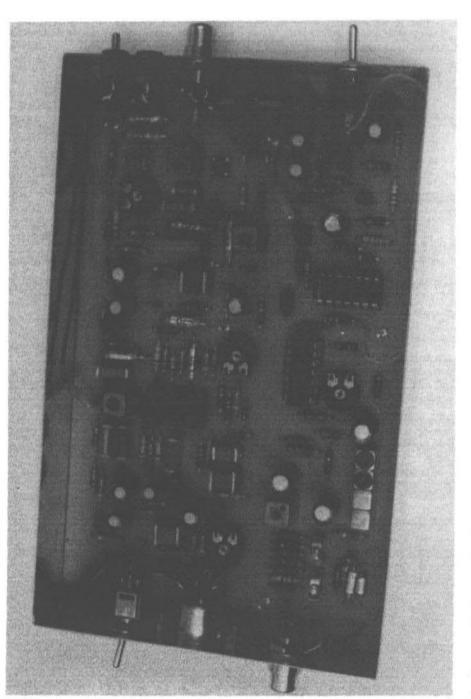


Fig. 11: A completed sample of the FM-ATV transmitter sound/vision unit



with the metal of the housing. It must be taken directly to the PCB point marked "GND Audio". This applies also to the video input where the cable mantle must be taken to the point marked "GND Video". This is simplified owing to the use of DIN "diode sockets" for both audio and video inputs. Cynch and BNC-sockets, if required, must also be in the isolated versions.

# 3. COMMISSIONING AND ALIGNMENT

Take supply potentials to the three parts of the circuit and check the current consumption. Video amplifier: when shorting the LED between T6 and T7, the current consumption should fall to some 5 mA — the final stage quiescent current. If a higher value is indicated, try another type of LED (older, dark red variety) or perhaps, three silicon diodes in series.

The carrier oscillator is adjusted to the nominal frequency by means of L3. L4 is adjusted for a maximum RF voltage at TP 3. Do not forget the wire or plug bridges A - B and C - D!

Operation without video pre-emphasis:

bridge A - D

Operation without video block filter:

bridge E - F

When all pots are set to their mid-range, the unit is ready for operation.

# 3.1. Fine-Tuning

With pot "video level", adjust to obtain 3  $V_{pp}$  at the output pin 3 whilst using the largest normal video input signal. Or, simply adjust until no signs of over-modulation are apparent on the monitor screen.

The audio voltages at TP 2 are given in table 1. The adjustment of the AF level can be carried out without instruments by listening tests from the TV set.

The 5.5 MHz level can be changed during the course of a TV contact but the sound-carrier frequency does not drift by more than 250 Hz.

The pot. "dynamic compression" is turned only as far that the noise in speech-pause periods is not audible — use headphones connected to TP 2 to check this.

#### 3.2. Notch-Filter

To adjust the notch-filter, feed in a 15.625 kHz signal to pin 2 preferably via a microphone which is standing close to a TV receiver. Adjust L1 for a minimum 15 kHz signal at TP 2. Using closely toleranced capacitors for the 0.1  $\mu\text{F}$  and the 47 nF, the resistor at the output I 1/pin 1 will be 698  $\Omega$  — otherwise, put a small pre-set in series and use it in conjunction with L1 to minimize the 15 kHz. Measure the resistance of the pre-set and replace it with a fixed resistor of equal value. Then fine-adjust L1.

# 4. REFERENCES

- (1) Sattler, G.: Baugruppen für frequenzmodulierte Amateurfunk-Fernsehsender (FM-ATV-Sender) in den GHz-Bereichen. Scriptum der Vorträge 32. Weinheimer UKW-Tagung (1987) S. 181 - 190
- (2) Grimm, J., DJ 6 PI: Frequency Modulated Amateur Television (ATV) VHF COMMUNICATIONS, Vol. 18, Ed. 3/1986, P. 165 - 176